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UNIVERSITY OF TECHNOLOGY

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SEAT Number:

Year-End Supplementary Examination 2022

Faculty of Natural Sciences

Department of Chemistry

Qualification: Dip. Analytical Chemistry	**Date:** December 2022
Subject and Level: Organic Chemistry II	**Venue:** Seme Hall
Subject Code: ORCH102	**Time:** 09:00 - 12:00
Total Marks: 120	**Duration:** 3 hours
Full Marks: 122	**Examiner:** Dr N.J. Gumede
Annexures: Steric hindrance due to diaxial interaction and periodic table.	**Moderator:** Mrs. C.M. Buthelezi
No. of Pgs. incl. cover page: 18	

Student Name: .....

Student's Signature: .....

Student Number: .....

Examiner's Signature: .....

Moderator's Signature: .....

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total	%
Marks allocated	10	11	15	13	15	14	10	17	17	122	100%
Examiner											
Moderator											

For office use only:

INSTRUCTIONS TO STUDENTS:

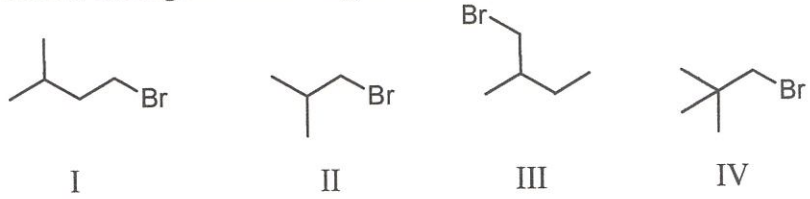
1. Answer all questions in ink.
2. Write all answers in the answer book or question paper provided.
3. Non-programmable calculators may be used.

Do not turn over until permission is given.

Question 1: Multiple choice

Circle only the correct answer in the following multiple-choice questions.

1.1 Which among the following bond-line structures is a set of constitutional isomers?

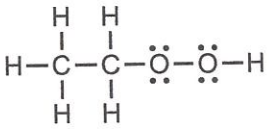


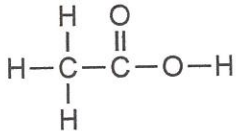
I II III IV

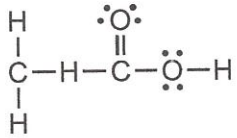
A) I and II
B) II and III
C) I, II, and III
D) II, III, and IV
E) I, III, and IV

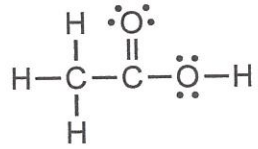
(2)

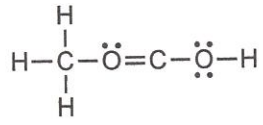
1.2 Which of the following is the Lewis structure for CH_3CO_2H?

A)


B)


C)


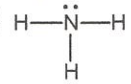
D)


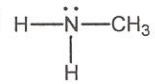
E)


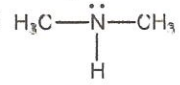
(2)

1.3 Which of the following molecules or ions has a nitrogen with a formal charge of -1?

A) 

B) 

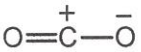
C) 

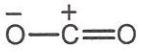
D) 

E) 

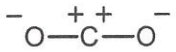
(2)

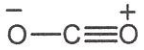
1.4 Which of the structures below is not expected to contribute to the CO_2 resonance hybrid?

A) 

B) 

C) 

D) 

E) 

(2)

1.5 When the *ls* orbitals of two hydrogen atoms combine to form a hydrogen molecule, which molecular orbitals are formed?

A) One bonding molecular orbital only
B) Two bonding molecular orbitals
C) One bonding molecular orbital and one antibonding molecular orbital
D) Two antibonding molecular orbitals
F) Three bonding molecular orbitals

(2)

[10]

Question 2: Introduction

2.1 There is only one compound that has a molecular formula C_2H_5Cl. Draw a dash-line structure of this compound.

(2)

2.2 Draw the Lewis dot structures of the following compounds presented below.

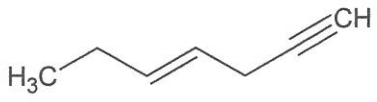
a) CH_2O

(1)

b) H_2SO_4

(1)

2.3 Identify the hybridization state of each carbon atom in the following compound.



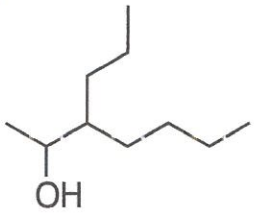
(7)

[11]

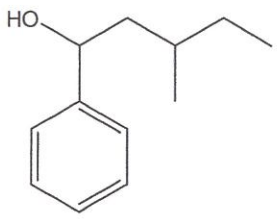
Question 3: Nomenclature of hydrocarbons

3.1 Predict the correct IUPAC substitutive names of the following alcohols.

a)



b)



(6)

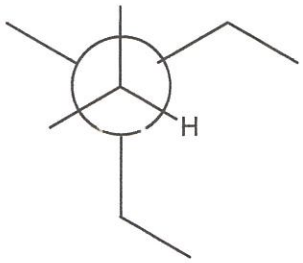
3.2 Propose three structures of branched alkyl groups, derived from pentane with five carbon atoms. (**Note:** Give their IUPAC and common names.)

(9)

[15]

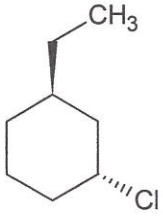
Question 4: Conformational analysis

4.1 Derive a bond-line structure from the staggered conformer given below. Give the name of this compound you have derived.



(4)

4.2 Propose structures of ring-flipped conformers of the compound presented below. (**Hint:** Indicate the position of equilibrium for the ring-flipped conformers)



(3)

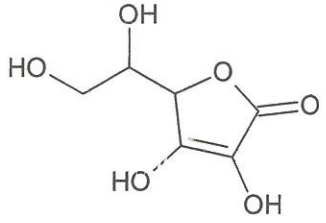
4.3 Predict the most and least stable chair conformer given in question 4.2 above? Give reasons to support your answer.

(6)

[13]

Question 5: Stereochemistry

5.1 Consider the structure of vitamin C (Ascorbic acid) shown below. Identify all chirality centers using an asterisk



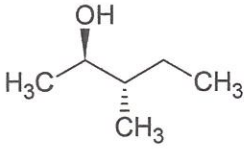
Vitamin C

(2)

5.2 Use the 2^n rule to predict the number of isomers exhibited by Vitamin C from question 5.1 above. Draw the 3D structures of the mirror images of Vitamin C you predicted using the 2^n rule.

(3)

5.3 Propose the complete name of the following compound using the R/S and/or Cahn-Ingold-Prelog system. (**Hint:** Show how you have assigned the configuration for more marks)

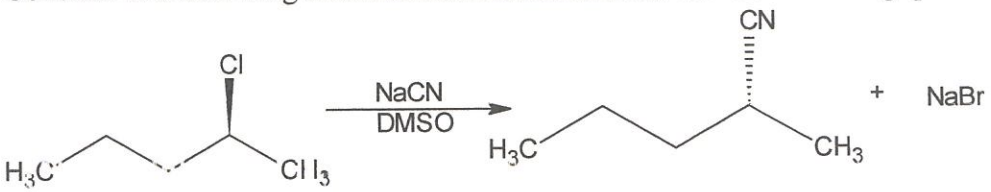


(10)

[15]

Question 6: Nucleophilic Substitution Reactions

6.1 Consider the following substitution reaction and answer the following questions.



a) Determine whether this reaction proceeds via an S_N1 or S_N2 process. Explain your reasoning to support your answer.

(3)

b) Will this reaction occur faster if DMSO solvent is replaced with ethanol? Explain your reasoning.

(3)

c) Propose a mechanism for this reaction.

(4)

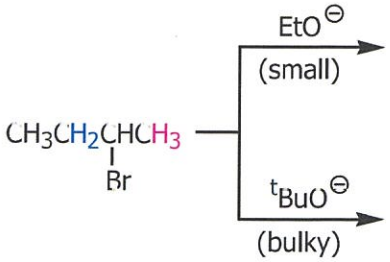
6.2 Discuss the nature of the leaving group in substitution reactions, giving examples to beef up your discussion.

(4)

[14]

Question 7: Elimination reactions

7.1 Predict the structures of the major and minor product(s) of the following elimination reactions in the reaction schemes below.



(4)

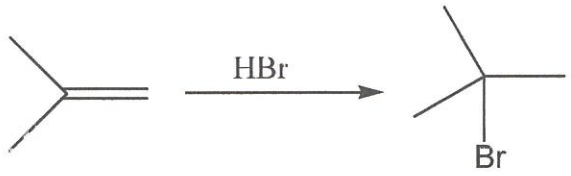
7.2 Identify the Zaitsev and Hoffman products in the products you predicted in question 7.1 above. Explain your reasoning for each for more marks.

(6)

[10]

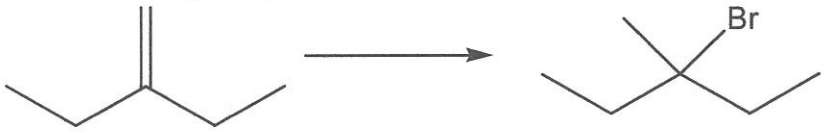
Question 8: Addition reactions

8.1 By means of a mechanism show how Markovnikov addition could be accomplished for a reaction that is shown below.



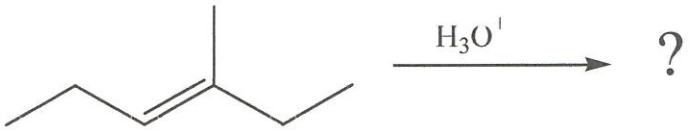
(5)

8.2 Provide the reagents you may use to accomplish the following transformation:



(2)

8.3 Predict the product(s) of the following acid-catalysed hydration of an alkene to form an alcohol.



(2)

8.4 Provide a mechanism of the reaction shown in 8.3 above.

(8)

[17]

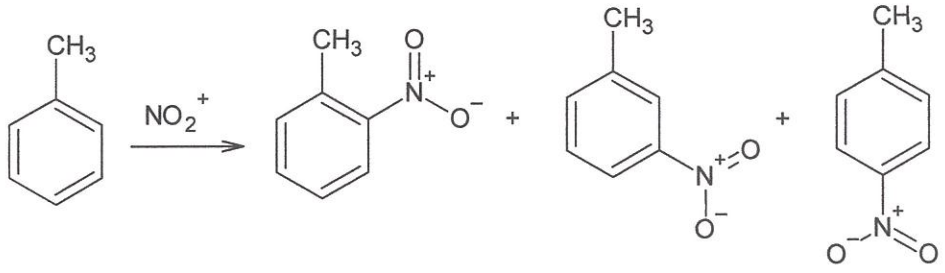
Question 9: Nomenclature and reactions of Aromatic compounds

9.1 Draw structures for each of the following compounds and provide their systematic names:

a) *p*-Chlorobenzoic acid

(2)

9.2 With the aid of mechanisms, explain why o-p attack is more favorable than the meta-attack in the following synthetic scheme presented below.



(15)

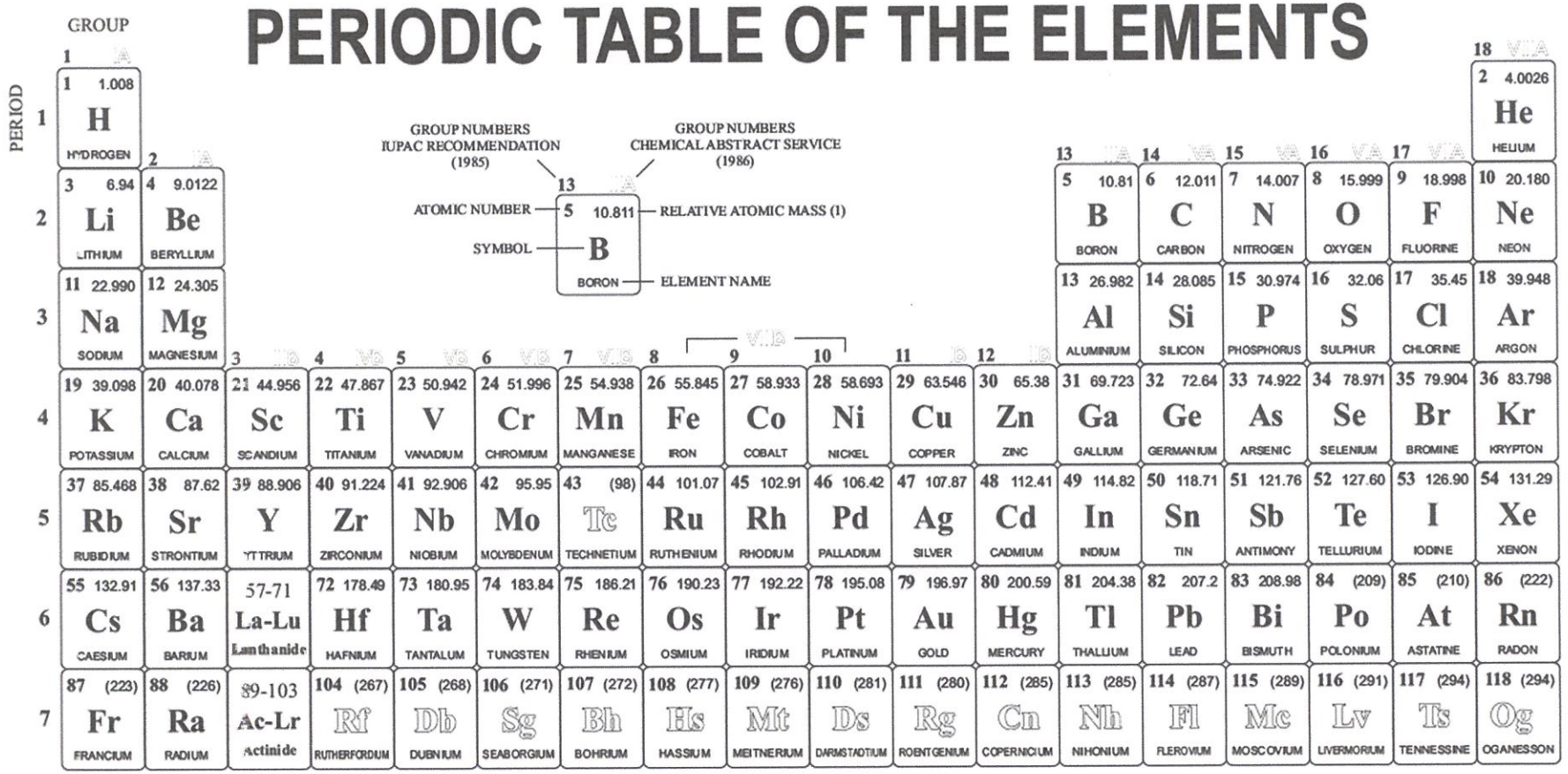
[17]

Table 1: 1.3-Diaxial interactions for several common substituents

Substituent	Steric hindrance from 1.3-Diaxial interactions (kcal/mol)
-Cl	2.0
-OH	4.2
$-CH_3$	7.6
$-CH_2CH_3$	8.0
$CH(CH_3)_2$	9.2
$-C(CH_3)_3$	22.8

$$[\alpha]_D^{25} = \frac{\alpha}{C \times L}$$

PERIODIC TABLE OF THE ELEMENTS



LANTHANIDE

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
138.91	140.12	140.91	144.24	(145)	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.05	174.97
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
LANTHANUM	CERIUM	PRASEODYMIUM	NEODYMIUM	PROMETHIUM	SAMARIUM	EUROPIUM	GADOLINIUM	TERBIUM	DYSPROSIUM	HOLMIUM	ERBIUM	THULIUM	YTTERBIUM	LUTETIUM

ACTINIDE

89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
(227)	232.04	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(262)
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
ACTINIUM	THORIUM	PROTACTINIUM	URANIUM	NEPTUNIUM	PLUTONIUM	AMERICIUM	CURIUM	BERKELIUM	CALIFORNIUM	EINSTEINIUM	FERMIUM	MENDELEVIUM	NOBELIUM	LAWRENCIUM

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(1) Atomic weights of the elements 2013, Pure Appl. Chem., 88, 265-291 (2016)